Space Weather Technical Forecast

Issued on Thursday, 12 January 2023 at 13:25 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: M-class flares (R1-R2 radio blackouts) expected. Chance of X-class (R3 radio blackouts). A possible glancing blow from a CME later on the 12th January.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity has been Moderate over the last 24 hours, two from AR3186 (Ehi/βγδ), with a peak flare of M1.5 at 12/0652UTC. A further M1.1 flare was observed emanating from AR3181 (Eki/βγ) towards the end of the period. There are four further numbered sunspot regions on the visible disc, with AR3184 (Eai/βγδ) the most complex in the southeast quadrant. AR3185 is also developing and is now classified as Dao/β. There is one unnumbered simple region in the north-centre region of the Sun. A CME appears to have been generated from the M1.5 flare, although this is only just emerging on C2 imagery although this is unlikely to be Earth-directed. No CMEs have been observed from the M1.1 flare. A large eruption to the north on coronagraph imagery is currently undergoing analysis to determine if it has an Earth-directed component.

Solar Wind / Geomagnetic Activity: Solar winds, as observed by DSCOVR at L1, have averaged around 400-450km/s, likely due to the influence of a high speed stream from coronal hole 62, as it rotates across the northwest limb. Density has been mainly around or just below average. Total magnetic field strength was at weak to moderate levels, varying between 5nT and 9nT. The north-south component has varied between weak positive and negative values throughout. Phi angle was predominantly negative (away from the Sun). Geomagnetic activity was Quiet (Kp 1-2).

Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10 MeV) as measured at GOES-16 was at background levels. High energy electron flux (greater than 2 MeV) has been at background levels. The 24-hour integrated electron fluence stayed well below the Active threshold on a steady trend, reaching 2.6e6 integrated pfu at 11/2359 UTC.

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Met Office Space Weather Technical Forecast

Four-Day Space Weather Forecast Summary
Solar Activity: Solar activity is likely to be Moderate, with a continuing slight chance of X-class flares due to a number of complex active regions on the visible disc.

Solar Wind / Geomagnetic Activity: A CME which left the Sun on 09 January could give a glancing blow at Earth later on 12 January, although this is a low probability and low confidence. No other Earth-directed CMEs are in the forecast, although a feature which left the Sun on 11 January will be analysed for a potential arrival. Solar wind speeds are around 400km/s due to a weak connection to coronal hole 62, with this likely to decline later on 12 January. No further coronal holes are then expected to connect with Earth during the forecast period. Geomagnetic activity is expected to be generally Quiet to Unsettled, although there is a slight chance of Active or G1/Minor Storm intervals later on 12 January and during 13 January due to the possible a glancing impact of the CME.

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux observed by GOES-16 is likely to remain at background levels throughout, but could increase should any significant flares occur, giving a slight chance of exceeding the S1/Minor Storm threshold, especially from regions in the western hemisphere. Electron fluence is likely to remain below the Active (1e8 integrated pfu) threshold.

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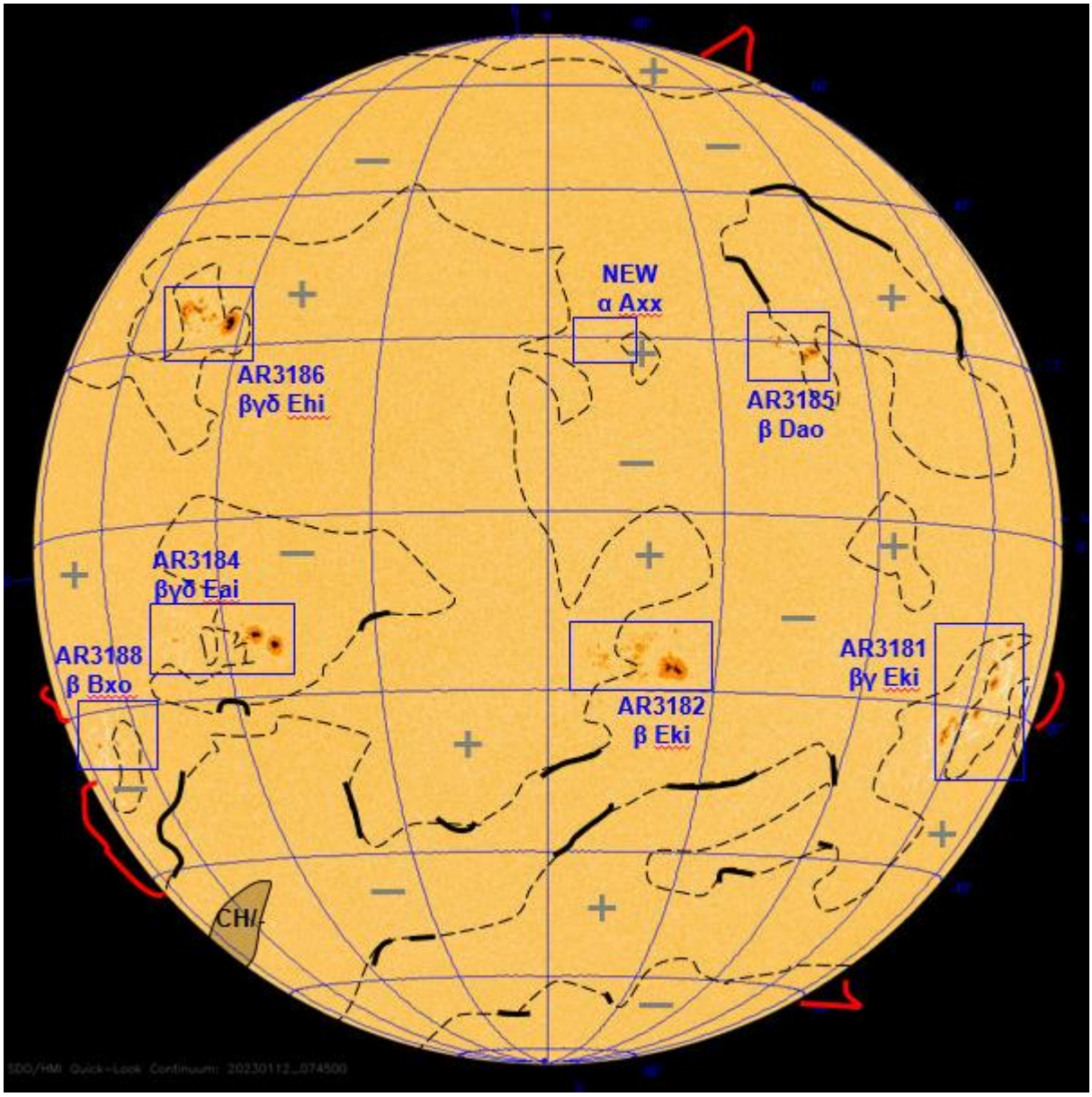
Figure 1. Solar Analysis Valid 12/0800UTC.



Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

A CME which left the Sun on 09 January is forecast to glance the Earth late on 12 January, with low confidence in both the possible arrival time and potential impacts. A further CME which left the Sun on 11 January is being analysed for a possible Earth-directed component.

A high speed stream from coronal hole 62 is currently affecting the Earth, with speeds around 400-450km/s. This is expected to decline through 12 January in the absence of any CME effects. No further coronal hole high speed streams are expected to connect with Earth through the period.

Geomagnetic activity is forecast to be mainly Quiet to Unsettled on 12 January, with a slight chance of Active or G1/Minor Storm intervals later in the day due to the possible CME, with further Active or G1/Minor Storm periods possible through 13 January. Mainly Quiet intervals are then expected through the remainder of the period.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	10	10	1	1
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
09/1908UTC	Partial	AR3181	SW quadrant	445km/s	Late 12 January	Limited and uncertain impact

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Figure 2: MOSWOC Enlil output and Enlil ensemble, showing forecast arrival time of 09 January CME.

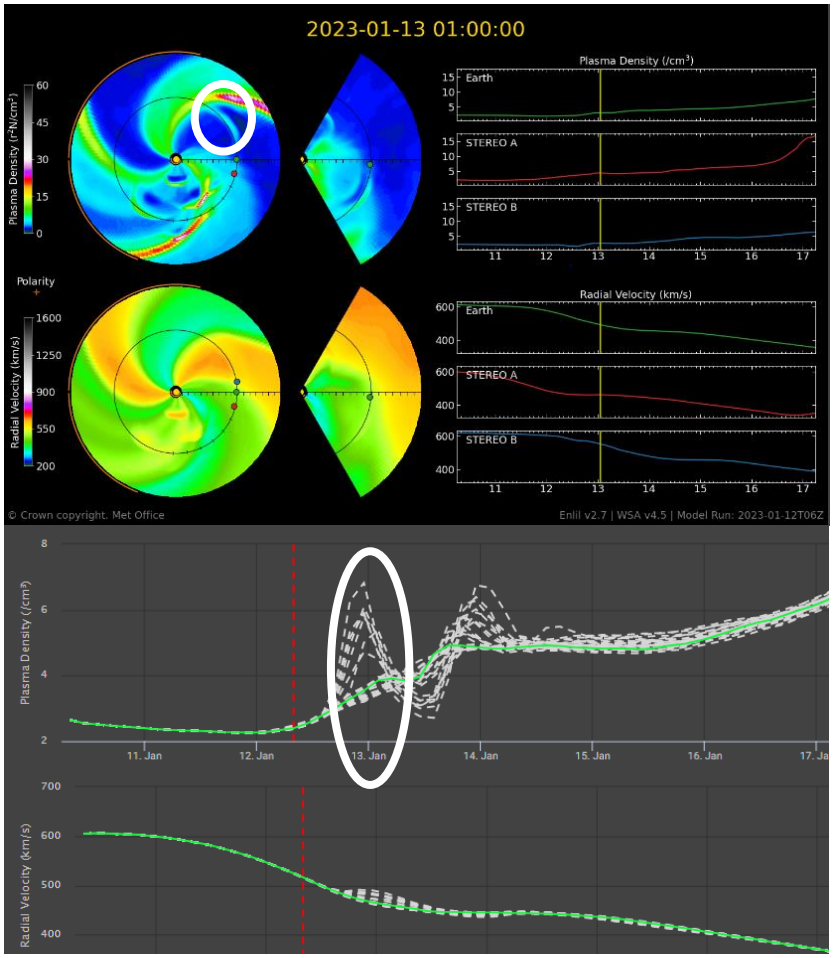
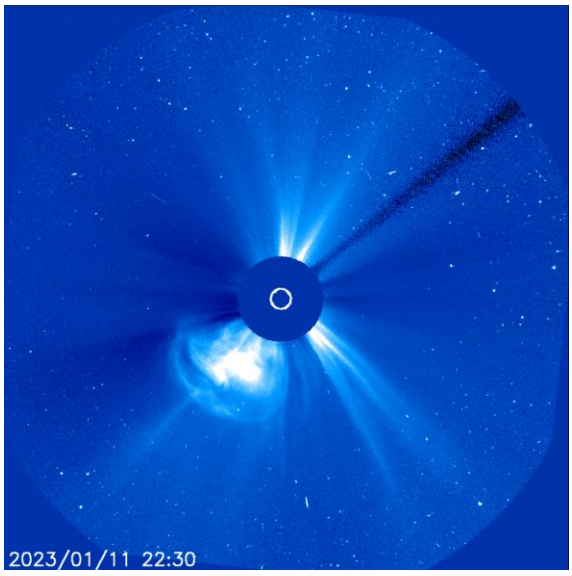


Figure 3: CME from 11 January which is awaiting further analysis.



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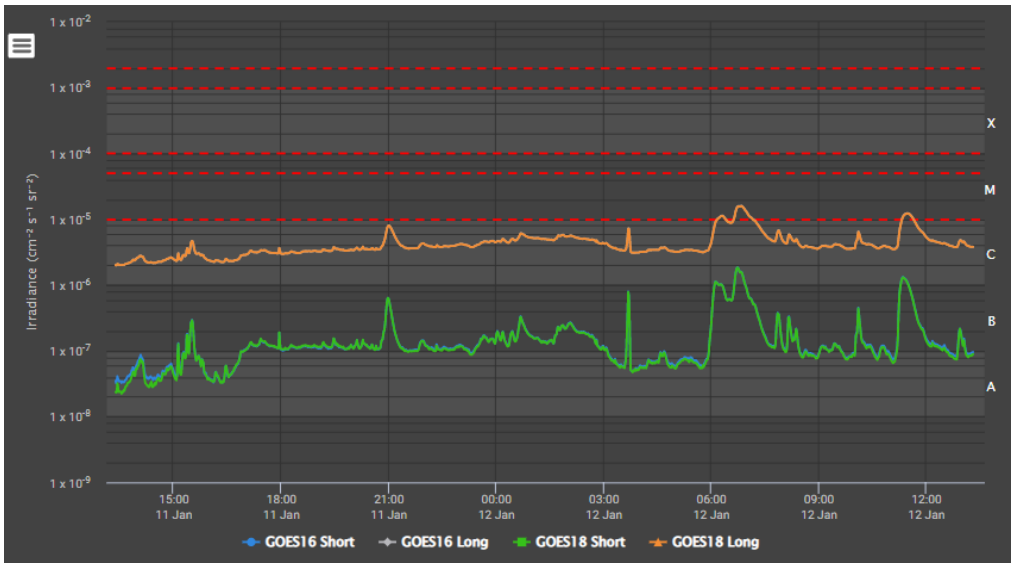
Radio Blackouts - X-Ray Flares:
Solar activity has been Moderate in the last 24 hours with three M-class flares, two from AR3186 in the northeast and one from AR3181. The flare in the northeast appears to have generated a CME, but with no evidence of a CME from the southwest currently available.

There are seven active regions on the visible disc in total with two of these containing delta spots (AR3184 and AR3186). Three regions, AR3181, AR3182 and AR3185 are complex and carry a significant flare risk. Two regions are simple with no notable development or activity. Far side seismographs are indicating plenty of additional potential activity on the far side, and there are signs on SDO imagery of another large active region appearing on the southeast limb with flux looping evident and some magnetic structure on magnetogram products.

Solar activity is expected to be mainly Low to Moderate, with a continuing risk of High activity from multiple M-class or any X-class flaring.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	Yes	80	80	80	80
Very Active	R3 to R5 X Class	No	25	25	25	25

Figure 4: GOES 18 X-ray flux



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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (greater than 10 MeV) measured by GOES-16 has been at background levels. However, any significant flares will bring a risk of proton flux rising, with a slight chance of exceeding the S1/Minor Storm threshold, especially from regions in the western hemisphere.

This is mainly due to the risk presented by both AR3182 and AR3181 as they are now rotating further westwards across the disc, towards a position where they are more likely to connect with Earth for proton storm events. AR3184 will also need monitoring in the coming days, depending on how it appears and potentially develops as it rotates more fully across the visible solar disc.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	20	20	20	20
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2MeV) is expected to vary between background to moderate levels under the influence of a relatively modest high speed stream, with significant distortion of the belts unlikely. The possible CME arrival could lead to a slight depression in the electron flux, followed by a limited increase.

Electron fluence values are expected to remain below the Active threshold, with no significant impact on electron counts through the period.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	1	5	1	10
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

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